

## AGE DISTRIBUTION AMONG NASA SCIENTISTS AND ENGINEERS

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## ABSTRACT

The loss of technical expertise through attrition in the technical workforce is a growing concern throughout NASA and the aerospace industry. A bimodal age distribution among scientists and engineers (S&Es) exacerbates the situation within NASA. This situation presents both challenges and opportunities to NASA managers as decisions are made that will shape the future of NASA.

This paper will document historical age-related information for S&Es within NASA in general, and at the NASA Lewis Research Center, Cleveland, Ohio, in particular, for 1968 through 1987. Recommendations are made to promote discussion and to establish the groundwork for action.

## INTRODUCTION

The technical competence and reputation of an organization is based on the competence of the individuals who comprise the technical workforce. In this context, the technical workforce contains both supervisory and nonsupervisory scientists and engineers (S&Es). These individuals form the core of institutional technical memory which is the marketable commodity of an organization.

Imagine an organization in which all the technical personnel are replaced with inexperienced personnel. The organization would certainly suffer since the commodity they offer, technical experience, has been eliminated. Conversely, an organization that exhibits a uniform distribution of experience among its technical personnel is less likely to suffer significantly as a result of the loss of their most experienced personnel, since only slightly less experienced personnel would be waiting to fill the vacancies.

A bimodal age distribution, i.e., with two distinct peaks or modes, may preclude a smooth personnel transition. Experienced senior S&Es will be replaced with relatively inexperienced junior S&Es rather than with midlevel S&Es, since few are available. Age (i.e., length of NASA service) and experience are highly correlated characteristics among NASA S&Es, contributing to their low attrition rate. Because of this correlation, institutional technical expertise is a strong function of the age distribution among the technical workforce. A detailed discussion of factors that resulted in the age distributions presented is beyond the scope of this paper.

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Early in the U.S. civilian space program, after the formation of NASA in 1958, many S&Es were hired directly from the collegiate ranks. These inexperienced, but enthusiastic, graduates acquired valuable experience as they matured along with the Mercury, Gemini, and Apollo programs.

In the late 1960s, forces external to NASA (e.g., Congress, OMB, the national budget, and others) dictated a decrease in the size of the NASA workforce, and a corresponding decrease in the number of S&Es. Figures 1 and 2 show, however, that even as the size of the total NASA workforce and the S&E population decreased, the percentage of S&Es increased (from 43 percent in 1968 to 51 percent in 1987).

The issue of technology loss through attrition must be addressed now. If we assume that the S&Es hired in 1958 were recent college graduates with an average age of 22, then these employees will be eligible to retire under the existing Civil Service Retirement System in 1991, since they will have at least 30 years of service and will be 55 years of age. Valuable institutional technical knowledge and experience will be lost when these employees retire.

It may not be feasible to replenish the pool of experienced personnel by hiring from outside NASA if the bimodal age distribution among NASA S&Es is representative of the aerospace industry in general. The size of the available S&E manpower pool in the U.S. workforce cannot be stated with certainty, but it has been reported that upwards of 50 percent of those earning B.S. degrees in S&E-related fields transfer out of the S&E field [1,2].

#### DATA

The following information was obtained from raw data and summary reports prepared by the NASA Personnel Evaluation and Analysis Division for the years 1968 through 1987 [3]. S&Es are defined by the following NASA positions:

##### Support Engineering and Related Positions

This includes professional physical science, engineering, and mathematician positions in work situations not identified with aerospace technology.

##### Aerospace Technology (AST) Scientific and Engineering Positions

This includes professional scientific and engineering positions requiring AST qualifications, and professional positions engaged in aerospace research, development, operations, and related work, including the development and operation of specialized facilities, and supporting engineering.

##### Life Science Positions

This includes life science professional positions not requiring AST qualifications, and medical officers and other positions performing

professional work in psychology, the biological sciences, and professions which support the science of medicine such as nursing and medical technology.

Table 1 presents the historical NASA S&E age data for 1968 through 1987. The age data has been categorized in the following age groups: less than 25 years of age, 25 to 29 years, 30 to 34 years, 35 to 39 years, 40 to 44 years, 45 to 49 years, 50 to 54 years, 55 to 59 years, and 60 years of age or more.

Figure 3 illustrates that the NASA S&E propulation has been aging along with NASA. The peak age-group shifted from 30 to 34 years of age in 1968, to 40 to 44 years in 1978, and to 50 to 54 years in 1987. A smaller, secondary age-group peak (25 to 29 years) appears on the 1987 curve as a result of an influx of new employees, primarily recent graduates. The magnitude of the primary age-group peak decreases only slightly between 1968 to 1987, once again contributing to the relatively low attrition rate among NASA S&Es, during that time as the age distribution shifts from a skewed normal to a bimodal age distribution.

Figure 4 contains the same information shown in Figure 3, but with the number of S&Es in each age group shown as a percentage of the total number of NASA S&Es. Since 1968, 19 to 23 percent of the total S&E population has consistently been concentrated in the peak age group.

Figure 5 further illustrates the aging of the NASA S&E population. The percentage of S&Es in the 35 to 49 age group has steadily decreased since 1970, while the percentage of S&Es in the over-50 age group has steadily increased (although at a slightly lower rate of increase than the rate at which the percentage in the 30 to 49 age group decreased). In addition, the decreasing trend in the percentage of S&Es in the under-35 age group was reversed about 1980.

The NASA Lewis data represents a microcosm of NASA's S&E trends. Table 2 presents the historical NASA Lewis S&E data for 1968 through 1987, during which NASA Lewis S&Es constituted 10 to 13 percent of NASA's S&E workforce. Figures 6 to 8 present NASA Lewis S&E data, comparable to the NASA S&E data presented in Figures 3 to 5.

Figure 9 illustrates that NASA's aging trend stabilized about 1979, and was effectively reversed about 1984, primarily as a result of the infusion of S&E new-hires and the inevitable loss of senior S&Es. The average age of NASA S&Es increased at a rate of 0.65 years per year between 1968 and 1978. Among NASA Lewis S&Es, the rate was a comparable 0.68 years per year.

#### RECOMMENDATIONS

The following is a list of recommendations which, although not comprehensive, attempts to promote discussion and to establish the groundwork for action. It includes measures that are extensions of or variations on existing NASA initiatives.

### Contractors/Consultants

Continue to use experienced S&E retirees through Support Service Contractors or as private consultants when comparable, but unavailable, S&Es are needed. This measure is particularly appealing when manpower funding (R&PM) is limited, but contracting funds (R&D) are available. Such an effort, however, should not detract from the development of an in-house technical workforce.

### Technical Mentor Programs

Establish and formally implement technical mentor programs that pair technical new-hires with experienced S&Es. Variations exist within some NASA organizational elements. For example, the NASA Ames Research Center (ARC) has introduced a new training program known as the Interactive Development of Engineers, Administrators, and Scientists (IDEAS) program. This program was specifically designed to counter the loss of institutional knowledge and experience arising from a bimodal age distribution in their S&E workforce.

### Documentation

Establish and promote a policy or policies that formally encourage or require documentation during the life of projects and programs. Valuable information is lost to NASA when adequate documentation does not occur until a program/project is either cancelled or completed. By then, it is often too late as personnel move on to other work or are not provided with the proper incentive to document their work. The feasibility of implementing such policy is enhanced by the existence of electronic storage media and telecommunications. As an example, the Space Station Technical and Management Information System (TMIS) is planned to serve as the knowledge base of information for the U.S. space station program, precluding the loss of key information resident in specific individuals.

### Employee Development Programs

Continue to promote programs that provide junior and midlevel S&Es with development opportunities for greater technical and/or managerial experience. These S&Es are likely to increase the pool of manpower that will be available to fill the roles vacated by senior S&Es. An example is NASA's Professional Development Program (PDP). The PDP allows selected NASA professional personnel to participate in a one year developmental program at NASA Headquarters and/or at a different NASA Center. Such a program broadens the individual's technical and organizational experience.

### Awareness Programs

Increase the dissemination of information on relevant issues through presentations and articles in technical and nontechnical forums, e.g., the Aerospace Mechanisms Symposium, employee newsletters, and technical journals.

### Chief Engineer/Scientist Positions

Promote positions for Chief Engineers/Scientists who report directly to the midlevel (second- or third-level) manager. Such positions enable a greater number of individuals to benefit from the experience of senior, nonsupervisory S&Es.

### Deputy Manager Positions

Establish and promote positions for deputies to first-level managers that allow junior S&Es to gain managerial experience on a probationary or rotating basis. These positions provide work experience while minimizing the risks associated with submerging an untrained individual in an unfamiliar role. Caution should be exercised to ensure that such positions do not generate an undesirable, and possibly unnecessary, level of bureaucracy.

### Hire Experienced S&Es

Efforts should be continued to attract experienced S&Es. As mentioned previously, the size of the pool of available experienced S&Es is an open question. S&Es are in demand now, but many may have made career changes in the 1970s. These changes are a result of factors such as the lucrative offers being made to the MBA candidates with technical backgrounds, as well as the downturn in employment opportunities in the aerospace and energy-related fields. However, as with the use of experienced S&E retirees, such efforts should not detract from the development of the existing in-house technical workforce.

### ACKNOWLEDGMENTS

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### REFERENCES

1. "The Science and Engineering Talent Pool." Proceedings of the 1984 Joint Meeting of the Scientific Manpower Commission and the Engineering Manpower Commission, National Academy of Sciences, Washington, D.C., May 15, 1984.
2. "The Technological Marketplace - Supply and Demand for Scientists and Engineers." Scientific Manpower Commission, May 1985.
3. Personnel Management Information System (PMIS) Reports from NASA Headquarters Personnel Programs Division, Washington, D.C.

TABLE 1. AGE DISTRIBUTION AMONG NASA SCIENTISTS AND ENGINEERS

Year	Age range									Total
	0-25	25-29	30-34	35-39	40-44	45-49	50-54	55-59	≥60	
1968	633	2168	2945	2767	2136	1874	815	347	166	13 851
1969	459	1946	2849	2829	2150	2097	900	406	203	13 839
1970	381	1718	2658	2914	2235	2167	1085	472	207	13 837
1971	286	1396	2435	2837	2243	2103	1248	477	202	13 227
1972	135	1109	2185	2746	2383	1950	1452	453	203	12 616
1973	89	801	2000	2594	2517	1900	1559	467	158	12 085
1974	108	606	1769	2524	2541	1888	1684	486	164	11 770
1975	153	521	1537	2408	2608	1962	1701	594	181	11 665
1976	186	468	1308	2264	2662	2050	1738	736	200	11 612
1977	167	456	1063	2072	2574	2314	1685	974	239	11 544
1978	176	503	874	1928	2528	2406	1683	1098	269	11 465
1979	199	503	728	1744	2475	2482	1671	1175	314	11 291
1980	349	598	725	1544	2379	2562	1733	977	333	11 200
1981	317	666	725	1343	2212	2551	1772	952	385	10 923
1982	328	710	660	1159	2060	2475	1927	966	461	10 746
1983	602	809	709	958	1940	2454	2049	1034	539	11 094
1984	557	909	706	842	1723	2379	2091	1074	598	10 879
1985	636	1168	781	837	1508	2269	2171	1137	637	11 144
1986	549	1375	887	862	1327	2120	2207	1183	637	11 147
1987	627	1612	1055	916	1229	2044	2206	1307	683	11 679

TABLE 2. AGE DISTRIBUTION AMONG NASA LEWIS SCIENTISTS AND ENGINEERS

Year	Age range									Total
	0-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	≥60	
1968	56	271	340	355	301	296	118	53	22	1812
1969	35	233	321	342	294	326	138	57	32	1778
<sup>a</sup> 1970	27	194	312	331	302	329	170	66	28	1757
1971	19	154	302	320	309	332	202	75	23	1736
1972	12	102	271	306	308	287	238	73	31	1628
1973	6	66	223	265	300	260	249	67	22	1458
1974	5	43	188	256	286	245	245	73	22	1363
1975	6	38	153	254	271	265	242	89	25	1343
1976	18	34	111	244	270	262	250	128	31	1348
1977	25	36	90	230	260	268	240	158	32	1339
1978	28	40	64	209	253	276	228	173	43	1314
1979	29	42	58	177	247	285	220	197	47	1302
1980	27	50	57	141	251	266	244	155	47	1238
1981	19	59	52	116	240	253	226	157	61	1183
1982	33	66	49	96	226	239	212	151	72	1144
1983	133	98	80	73	213	236	227	148	88	1296
1984	122	112	79	64	180	240	233	156	91	1277
1985	114	176	87	74	146	247	226	173	94	1337
1986	46	218	92	75	122	231	230	161	104	1279
1987	56	249	127	92	108	228	229	164	120	1373

<sup>a</sup>Figures for 1970 were obtained through interpolation of the data from 1969 and 1971.

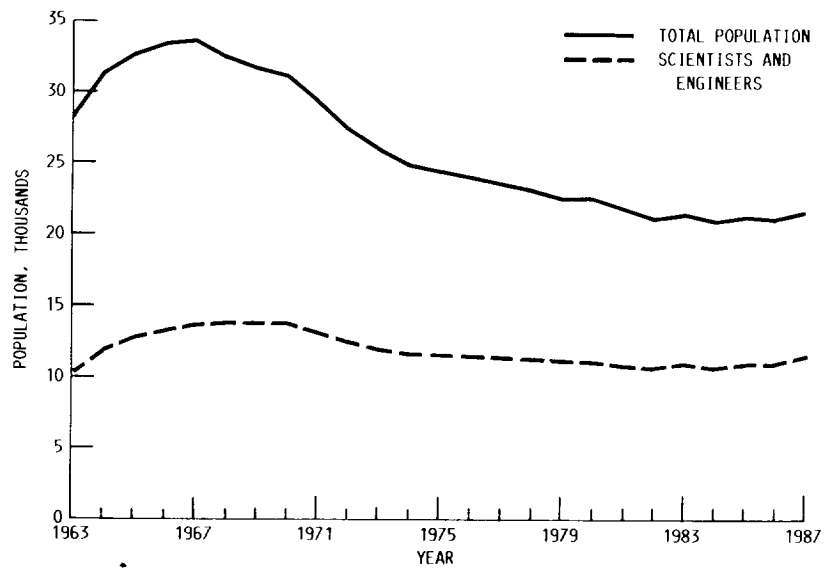


Figure 1. NASA Civil Service population.

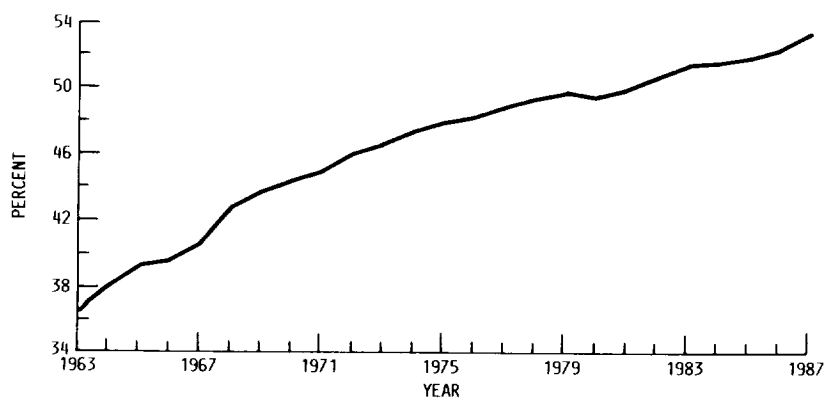


Figure 2. S&Es as a percent of the total NASA Civil Service population.

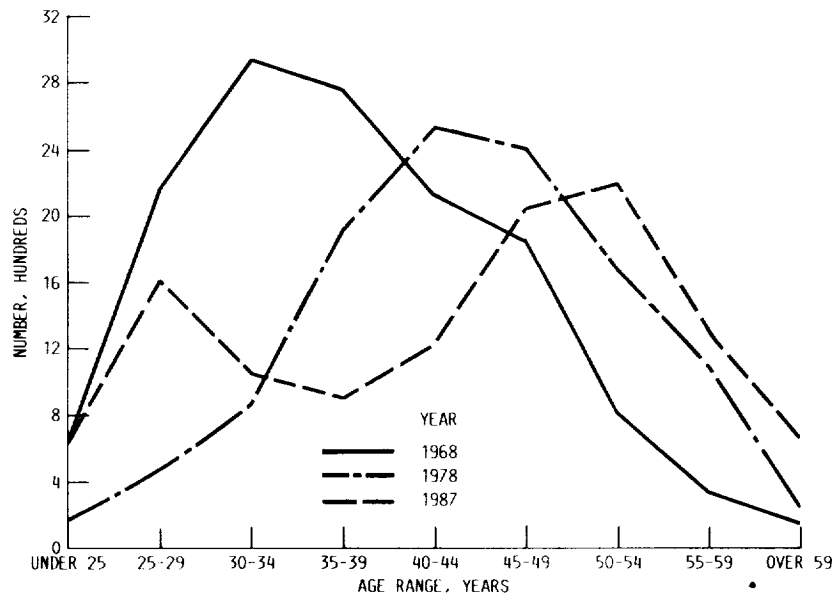


Figure 3. Age distribution among NASA S&Es (number).

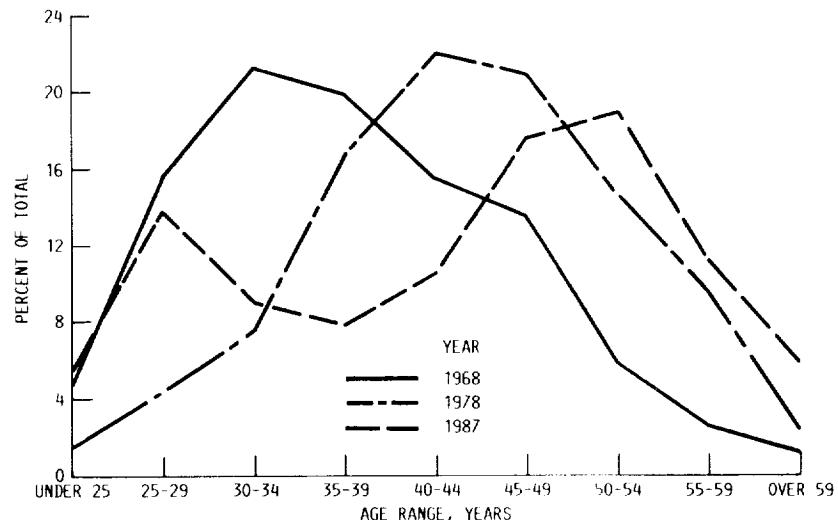


Figure 4. Age distribution among NASA S&Es (percent).



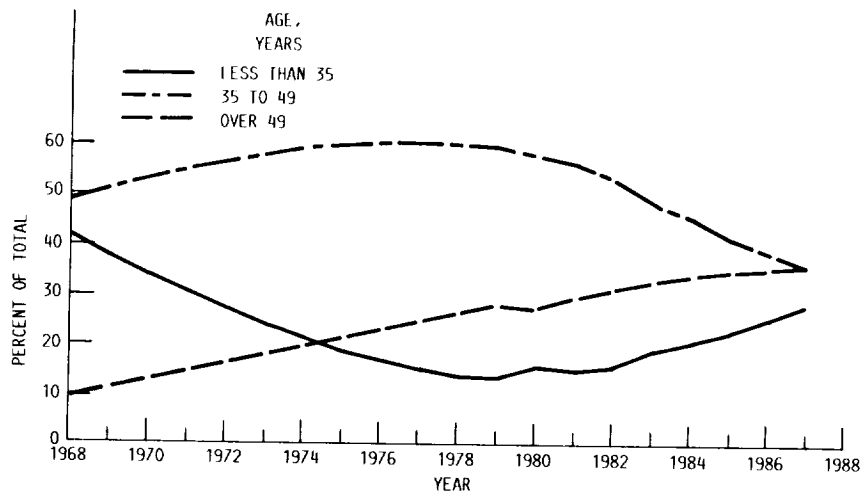


Figure 5. Percent of NASA S&Es in given age ranges.

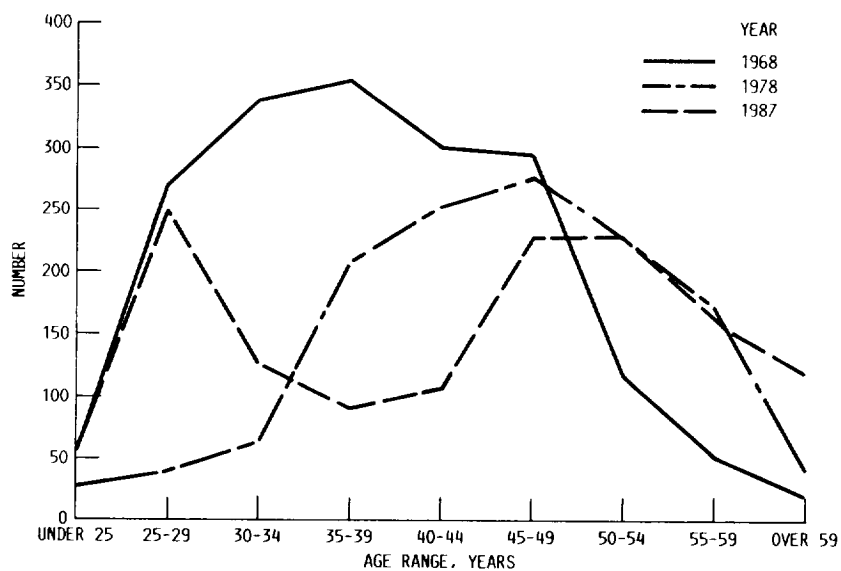


Figure 6. Age distribution among LeRC S&Es (number).

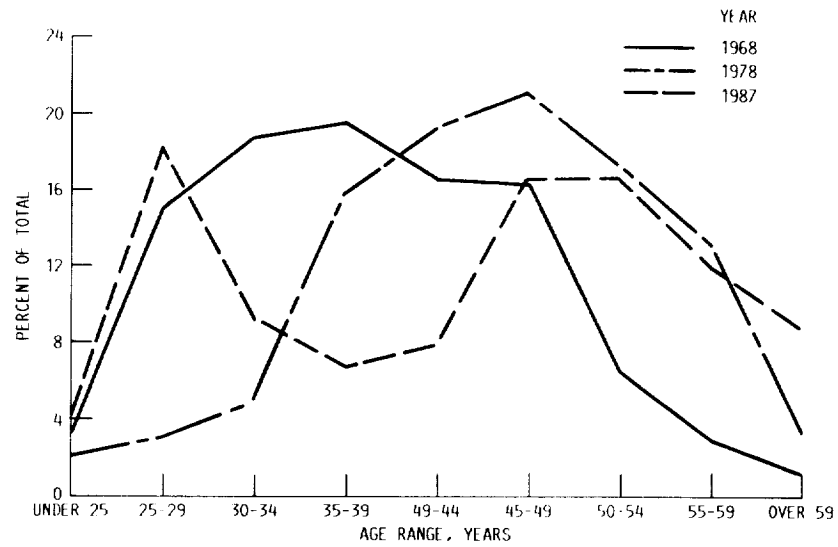


Figure 7. Age distribution among LeRC S&Es (percent).

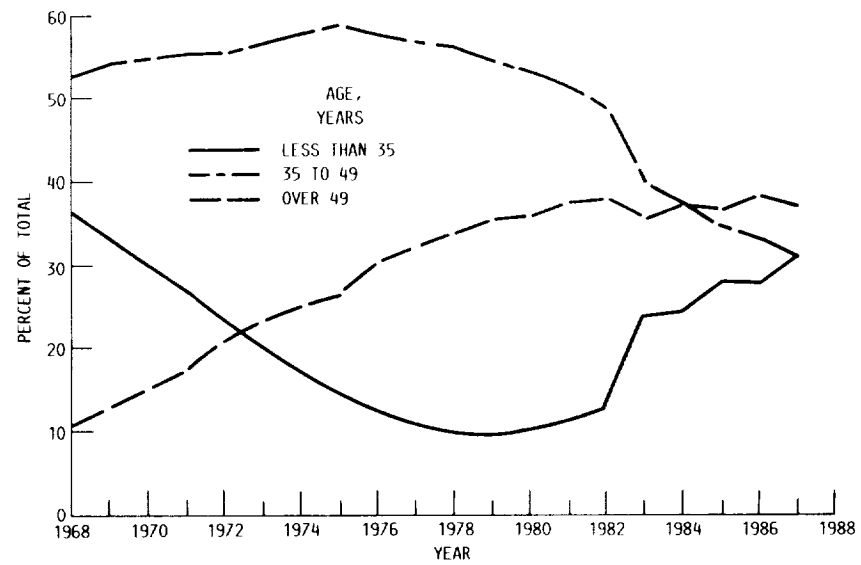


Figure 8. Percent of LeRC S&Es in given age ranges.

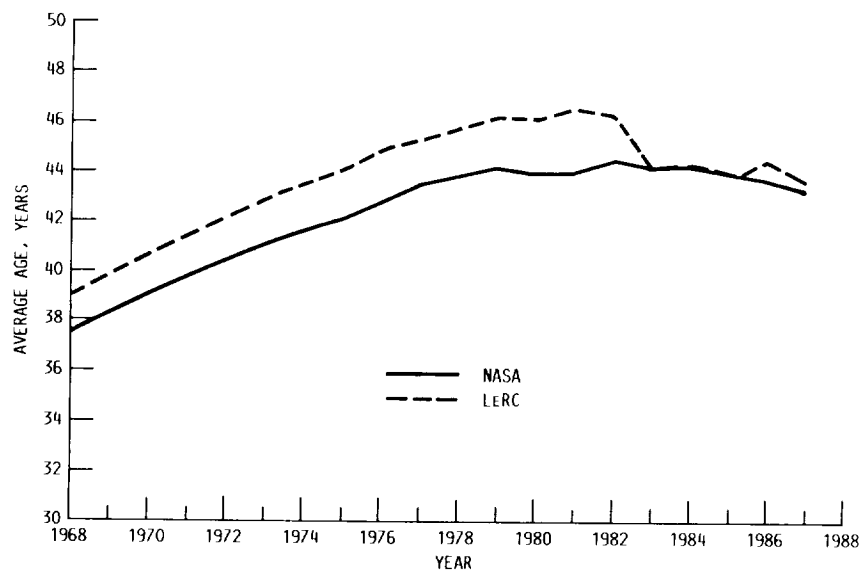


Figure 9. Average age of NASA and LeRC S&Es.

